

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Smith, et al.

Serial No.: 9/660,257

Filed: 09/12/2000

Title: METHODS AND MIXTURES FOR TREATING DISTRESSED TREES

Art Unit: 3643

Examiner: Gellner

Hon. Commissioner of Patents

Box Fee Amendment

Washington, D. C. 20231.

AFFIDAVIT

WHEREAS, the undersigned,

I, Scott D. Russell, resident of 3001 Oak Tree Ave. #D14, Norman, County of Cleveland, Oklahoma 73072-8038 do hereby state that:

I am George Lynn Cross Research Professor of Botany; and Director of Samuel Roberts Noble Microscopy Laboratory at the University of Oklahoma in Norman, Oklahoma. In addition, I am Managing Editor of *Sexual Plant Reproduction* and President of the Botanical Society of America.

The applicants Dr. Don Smith and Peter Martin requested that I examine the patent application for "Methods and mixtures for treating distressed trees" attorney docket 22601-P002US. While I am not trained in the legal aspects of the challenges to his application, I have restrained myself to matters of botanical knowledge. My background is that of a professional botanist. My

EXHIBIT

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curriculum vita is available for inspection on the web at <http://www.ou.edu/cas/botany-micro/faculty/sdr-vita.shtml> and has been included as a separate attachment to this filing and includes all education, publications, presentations, and recognitions that I have received to date.

I have attached a point-by-point examination of the findings of the United States Patent and Trademark Office in rejecting Dr. Smith's patent application.

If there are any questions regarding these findings, I can be reached at the address and contacts given above.

**This is in response to the Office Communication from the US Patent and Trademark Office on 22601-P002US, mailed 06/05/2002.**

Claims 1-25 are rejected largely on the basis that (1) the claims do not distinctly delineate the subject matter which the applicant regards as the invention, (2) others held the patent rights or (3) the techniques were obvious to one skilled in the art at the time of the application. In fact, neither is true, as existing patents relate to plant propagation and the art does not address problems of native tree interactions in soil conditions in artificially modified environments.

**Regarding the rejection of claims on the basis that the claims do not distinctly delineate the subject matter which the applicant regards as the invention:**

- 1) "Established" plants can be described specifically and an objective standard can be obtained because it is dependent on the plant reaching maturity and bearing extensive secondary growth as defined in all conventional botany texts and plant structure resources currently available.
- 2) "Adult" plants is clearly described in morphology texts as consisting of (1) a syndrome of progressive changes in leaf organization (called heteroblasty) that range from juvenile leaves (starting just above the cotyledonary node of the seedling) to a stable mature form at sexual maturity; (2) onset of production of appropriate sexual organs.

**Regarding the rejection of claims on the basis that others held the patent rights:**

- 1) The most critical existing patent is 4,417,417 of Mehra-Palta, which is used to reject Claims 1, 2, 4, 5, 7, 10, 15, 22-25. This patent concerns the use of a cytokinin hormone to stimulate the formation of adventitious buds until these produce rootable shoots in gymnosperms. The procedure also included pulse treatment in a phenolic compound and an auxin to produce roots subsequently. The critical points follow:
  - a) Mehra-Palta (4,417,417) exclusively uses culture media *in vitro* on tissue culture cells, not organisms. *In vitro* preparation involves severing a part of the plant from an existing plant and each plant part creates a new plant. The creation of a separate plant does not anticipate the rescue of an existing parent plant.

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- b) In *in vitro* culture, differentiation is preceded by the formation of an undifferentiated tissue called **callus** that lacks organs and any indication of organography. This means that the material cannot be distinguished as root or stem. There is no evidence for the formation of callus in roots of post oak. The method of production of plantlets is described as an **embryogenetic process** involving the production of polarized embryos.
- c) The claim of Mehra-Palta is the production of **adventitious buds via cytokinin treatment**. Buds are defined as nascent stems with their associated leaves. Smith claimed proliferation of roots via cytokinin and auxin treatment. Mehra-Palta makes no claim that cytokinins produce roots.
- d) Mehra-Palta use a pulse of auxin only once plantlets are produced. The auxin is added to stimulate the stems created by the cytokinin treatment to form roots.
- e) This patent does not anticipate the combination of cytokinins with auxin. In fact, if they added the two components, the callus would never produce stems and therefore the principal goal of the patent would not be achieved. Stimulation of **stems** created using the cytokinin procedure to produce roots occurs **subsequent to shoot formation**.
- f) The Smith claims are based on stimulating the formation of **roots from roots** in vivo, creating a **rescue situation** where an **adult plant is maintained in situ** under circumstances in which it would normally die. No claim is made that stems (adventitious buds) are produced from the root. There is no embryogenetic process involved. Vegetative proliferation is the sole effect, and this from tissue that is already differentiated as solely root.
- g) If the Smith application followed protocols of Mehra-Palta, a small segment of a tree would need to be removed to culture tissue from the plant. This material would form new plants in culture that could be planted in the place of the old plant. The old plant, however, would still be dead or dying. This does not meet the goals of the Smith patent application. (It seems reasonable to comment that producing new trees using seed would be easier and more cost effective than using the Mehra-Palta method.)
- h) “Establishment” in the sense of Mehra-Palta means living tissues that can be introduced into the environment as independent plants. “Establishment” in the sense of Smith means mature trees with extensive periderm and rhytidome accumulation (bark), which for oaks would typically be significantly in excess of 10 years.
- i) Mehra-Palta patent 4,417,417 never uses the word “distressed” to describe either individual plants or species. A close examination of the patent indicates that they are not interested in saving individual plants, but reproducing genetically superior plants using a faster method than available in the past. Further, they are interested in selecting genetically superior plants for culture. Smith is interested in saving trees subjected to the stress of environments altered by man.

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- j) In the sense of Mehra-Palta it could be anticipated that "distressed" plants would not be selected for culture as plants that are not performing well in their environment would not produce suitably superior genetic plants and therefore would not be selected for further research or cloning.
- k) The patent did not address plants to be established in the environment. Their protocol assumed that "normal treatment" (not discussed in their patent) would be required after their introduction into the environment. Thus, the Mehra-Palta patent does not anticipate the treatment of plants in soil.

2) Claims 18 and 21 are rejected on the basis of anticipation of the technique by Dale (Fred Dale Special to the Star).

- a) Dale described transplanting commercially-available horticulturally bred trees of typically three to five years of age. In contrast, Smith describes treating native plant species of typically 10 or more years of age, *in situ*.
- b) Use of transplantation as described by Dale would result in tree death, and is also quite impractical for trees that have accumulated over a ton of biomass. It is further unclear why the article by Dale is a priority description for cyclic watering.

**Regarding the rejection of claims on the basis that the techniques were obvious to one skilled in the art at the time of the application:**

- 1) Regarding Claim 3, it is not obvious that a 1000-cell plantlet would replace a 10-50 year old tree.
- 2) Regarding Claim 6, alteration of N, P and K concentrations to specific numbers is not obvious and is the subject of study and experimentation under field conditions. Mehra-Palta did not describe or advocate specific N, P or K concentrations on sexually mature plants.
- 3) Regarding Claims 8 & 9 and 16 & 17, suitability of a specific fungicide is obvious, but determining the harmony of a specific fungicide with regard to a specific application is not obvious and is the subject of study and experimentation under field conditions.
- 4) Regarding Claims 11-13 and 14, Mehra-Palta described an entirely different application of hormones presented in pulses with the goal of establishing plantlets from tissue culture. The cytokinin was designed to stimulate buds, which are stems and leaves. Smith used cytokinin to cause existing roots (not stems or roots) to proliferate. In tissue culture, the use of Smith's protocol would not result in the formation of plantlets if cytokinin was used simultaneously with auxin.
- 5) Regarding Claim 19, the Smith proposal applies both auxin and cytokinin and is therefore distinct from prior state-of-the-art, which would contend that use of both would be counterproductive for roots in tissue culture.

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6) Regarding Claim 20, the use of a water jet is not obvious as it is the subject of study and experimentation under field conditions.

**Note:** The views expressed on these pages represent those of the above person and do not necessarily reflect the views of, or represent endorsements by, the University of Oklahoma, the journal *Sexual Plant Reproduction* or the Botanical Society of America.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

The Commissioner is hereby authorized to charge any fees or credit any overpayment to Deposit Account Number 23-2426 of WINSTEAD SECHREST & MINICK P.C.

If the Examiner has any questions or comments concerning this paper or the present application in general, the Examiner is invited to call the attorney for the patent applicants, James J. Murphy at (214) 745-5374.

Maker of Affidavit's signature:

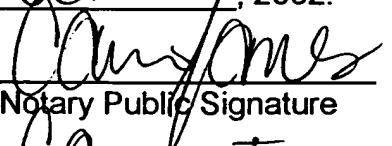
State of Oklahoma

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\_\_\_\_\_  
Scott D. Russell

Before me, Carrie Jones, a notary public, on this day personally appeared 10-01-02, known to me to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same for the purposes and considerations therein expressed.

Given under my hand and seal on the 1 day of OCT, 2002.

  
\_\_\_\_\_  
Notary Public Signature  
  
\_\_\_\_\_  
Notary Public Printed Name

# CURRICULUM VITAE

## SCOTT D. RUSSELL

- General Information
- Education
- Professional Experience
- Honors
- Research Funding
  - External
  - Internal
  - Instructional
- Teaching
- Publications
  - Scientific Publications
  - Scientific Presentations
  - Invited Presentations
  - Published Abstracts

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# CURRICULUM VITAE

## SCOTT D. RUSSELL

DATE OF BIRTH: December 8, 1952

PLACE OF BIRTH: Milwaukee, Wisconsin

MARITAL STATUS: Divorced, one child, Eric (1988)

EDUCATION:

<u>Years</u>	<u>School</u>	<u>Degree</u>
1975	University of Wisconsin-Madison	B.A. in Botany
1977	Northern Arizona University-Flagstaff	M.S. in Biology
1981	University of Alberta-Edmonton, Canada	Ph.D. in Botany

PROFESSIONAL EXPERIENCE:

<u>Years</u>	<u>Organization</u>	<u>Position Held</u>
1976-1977	Northern Arizona University	Teaching Assistant
1977-1980	University of Alberta	Teaching Assistant
1980-1981	University of Alberta	Predoctoral Fellow
1981-1982	University of Oklahoma	Acting Assist. Professor
1982-1987	University of Oklahoma	Assistant Professor
1989	École Normale Supérieure de Lyon	Chair privée
1987-1992	University of Oklahoma	Associate Professor
1992-2000	University of Oklahoma	Professor
1997	University of Melbourne	Visiting Professor
1984-	Samuel Roberts Noble Electron Microscopy	Director

present	Laboratory	
2000- present	University of Oklahoma	George Lynn Cross Research Professor

HONORS:

1980-81 University of Alberta Dissertation Fellowship  
 1986-87 OU Associates Distinguished Lecturer  
 1987 Focus on Excellence - Samuel Roberts Noble Electron Microscopy Laboratory - O.U. Faculty Senate  
 1988 Jeanette Siron Pelton award for sustained and imaginative research in experimental plant morphology, Botanical Society of America  
 1992 Diatom Award for best electron microscopic work on sectioned biological or physical sciences specimens at the annual meeting of the Electron Microscopy Society of America, second prize with H.-S. Yu.  
 1994 Regents' Award for Superior Research and Creative Activity, University of Oklahoma.  
 1997 Microscopy Society of America Award for best microscopic poster in the biological sciences at the annual meeting of the Microscopy Society of America, second prize with Z. Zhang.  
 1998 Special Service Award for efforts in website development and inaugurating *American Journal of Botany* online, Botanical Society of America.  
 2000 George Lynn Cross Research Professorship, University of Oklahoma.  
 2001 Special Service Award for efforts in website development, Botanical Society of America.  
 2001-02 President-Elect, Botanical Society of America.  
 2001- Managing Editor, *Sexual Plant Reproduction*.  
 2002- President, Botanical Society of America.

Awards to Students

1997 Dissertation Award presented to Stephen D. Fields for his dissertation entitled "Ultrastructural and physiological analysis of the nascent symbiosis between *Gymnodinium acidotum* (Dinophyceae) and *Chroomonas* sp. (Cryptophyceae)" Ph.D., April 1996

TEACHING:

- General Botany (BOT 1114)
- Cell Biology (BOT/MBIO/ZOOL 3113)
- Plant Anatomy (BOT 4283)
- Transmission Electron Microscopy (BOT/MBIO/ZOOL 5364)
- Scanning Electron Microscopy (BOT/MBIO/ZOOL 5374)
- Comparative Morphology of Vascular Plants (BOT 5624)
- College of Liberal Studies Introductory Seminars (BLS program)
- Special Courses in Freeze Fracture Electron Microscopy and Scientific Graphics
- Independent Study courses in Plant Anatomy, Electron Microscopy and Plant Cell Biology
- Graduate Supervision

PAPERS IN SCIENTIFIC PUBLICATIONS:

| 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |  
 | 1998 | 1999 | 2000 | 2001 | 2002 |

1. Russell, S. D. 1979. Fine structure of megagametophyte development in *Zea mays*. Can. J. Bot. 57: 1093-1110.
2. Russell, S. D. 1980. Participation of male cytoplasm during gamete fusion in an angiosperm. *Plumbago zeylanica*. Science (Washington, D.C.) 210: 200-201.
3. Russell, S. D. and D. D. Cass. 1981. Ultrastructure of fertilization in *Plumbago zeylanica*. Invited paper of the VI Symposium on Plant Cytoembryology. Lublin, Poland. Acta Societatis Botanicorum Poloniae. 50: 185-189.
4. Russell, S. D. and D. D. Cass. 1981. Ultrastructure of the sperms of *Plumbago zeylanica*. I. Cytology and association with the vegetative nucleus. Protoplasma 107: 85-107.

5. Russell, S. D. 1982. Fertilization in *Plumbago zeylanica*: Entry and discharge of the pollen tube within the embryo sac. *Can. J. Bot.* 60:2219-2230.
6. Russell, S. D. and D. J. Petuya. 1982. A simple, rapid method of staining grids for transmission electron microscopy. *Ok-SEM Bull.* 4(2):9-10.
7. Russell, S. D. and D. D. Cass. 1982. Unequal distribution of plastids and mitochondria during sperm cell formation in *Plumbago zeylanica*. In: *Pollen: biology and implications for plant breeding*. Ed. D. L. Mulcahy and E. Ottoviano. Elsevier Biomedical. New York. pp. 135-140.
8. Russell, S. D. 1983. Fertilization in *Plumbago zeylanica*: Gametic fusion and fate of the male cytoplasm. *Amer. J. Bot.* 70:416-434.
9. Russell, S. D. 1983. Gametic fusion in *Plumbago*. *BioScience* 33: 390.
10. Russell, S. D. and D. D. Cass. 1984. Ultrastructure of gamete fusion in *Plumbago zeylanica*. Invited paper of the VII Symposium on Embryogenesis of Ovulated Plants. Bratislava, Czechoslovakia. pp. 245-248.
11. Russell, S. D. 1984. Timetable of fertilization. *Pollination '84 Symposium volume*. University of Melbourne, Melbourne, Australia. pp. 69-77.
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16. Russell, S. D. 1985. Sperm-specificity in *Plumbago zeylanica*. *Proceedings of VIII Symposium on Sexual Reproduction in seed plants, ferns and mosses*. PUDOC, Wageningen, Netherlands. pp 145-146.
17. Russell, S. D. 1985. Preferential fertilization in *Plumbago*: ultrastructural evidence for gamete-level recognition in an angiosperm. *Proceedings of the National Academy of Science (USA)*. 82:6129-6132.
18. Russell, S. D. and C. P. Daghlian. 1985. Scanning electron microscopic observations on deembedded biological tissue sections: comparison of different fixatives and embedding materials. *Journal of Electron Microscopy Technique* 2: 489-496.
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29. Russell, S. D. and D. D. Cass. 1988. Fertilization in *Plumbagella micrantha*. *American Journal of Botany*. 75:778-781.
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32. Russell, S. D. 1989. Fertilization in *Plumbago zeylanica* - a review. *Phytomorphology* 39:1-20.
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36. Strout, G. W. and S. D. Russell. 1990. A micro-sample critical point drying apparatus for small specimens. *Journal of Electron Microscopy Technique* 14:175-176.
37. Russell, S. D. 1990. A method for improved resolution for fluorescence microscopy using plastic-embedded material subjected to resin extraction. *Stain Technology* 65:259-261.
38. Roeckel, P., A. Chaboud, E. Matthys-Rochan, S. Russell and C. Dumas. 1990. Sperm cell structure, development and organization. In: *Microspores-evolution and ontogeny*, (S. Blackmore and R. B. Knox, eds.) Academic Press, London, pp. 281-307.
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42. Russell, S. D. 1990. Isolation and characterization of the angiosperm gamete. NATO Ast Series. Series H. Cell Biology Vol. 45 In: Mechanism of fertilization: plants to man. (B. Dale, ed.) Springer-Verlag, Heidelberg, pp. 3-15.
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44. Russell, S. D., M. Cresti, and C. Dumas. 1990. Recent progress on sperm characterization in flowering plants. *Physiol. Plantarum* 80: 669-675.
45. Huang, B.-Q., S. D. Russell, G. W. Strout, and Mao L-J. 1990. Organization of isolated embryo sac and eggs of *Plumbago zeylanica* (Plumbaginaceae) before and after fertilization. *Amer. J. Bot.* 77:1401-1410.
46. Russell, S. D. 1990. Energy-dispersive x-ray microanalysis of cellular components in the pollen of an angiosperm, *Plumbago zeylanica*. XII International Congress for Electron Microscopy Proceedings pp. 804-805.
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48. Rougier, M., N. Jnoud, C. Said, S. Russell and C. Dumas. 1991. Male gametophyte development and formation of the male germ unit of *Populus deltoides* after self-pollination. *Protoplasma* 162:140-150.
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53. Huang, B.-Q., and S. D. Russell. 1992. Female germ unit: organization, isolation and function. *International Review of Cytology* 140: 233-293.
54. Russell, S. D. 1992. Double fertilization. *International Review of Cytology* 140: 357-388.
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70. Yu, H.-S. and S. D. Russell. 1994. Male reproductive cell development in pollen tubes of *Nicotiana tabacum*: male germ unit associations and quantitative cytology during sperm maturation. *Sexual Plant Reproduction* 7:324-332.
71. Yu, H.-S., B.-Q. Huang and S. D. Russell. 1994. Transmission of male cytoplasm during fertilization in *Nicotiana tabacum*. *Sexual Plant Reproduction* 7:312-323.
72. Huang, B.-Q. and S. D. Russell. 1994. Fertilization in *Nicotiana tabacum*: Cytoskeletal modifications in the embryo sac during synergid degeneration. A hypothesis for short distance transport of sperm cells prior to gamete fusion. *Planta* 194:200-214.
73. Russell, S.D. 1994. Fertilization in higher plants. In *Pollen-Pistil Interactions*. *Proceedings of the 9th Annual Penn State Symposium in Plant Physiology*, American Society of Plant Physiology, Washington, D.C., pp. 99-111.
74. Yu, H.-S. and S. D. Russell. 1994. Quantitative differences in sperm cells and organelles of tobacco (*Nicotiana tabacum* L.) grown under differing environmental conditions. *Theoretical and Applied Genetics* 89: 7814-817.
75. Yu, H.-S., and S. D. Russell. 1994. Occurrence of mitochondria in the nuclei of *Nicotiana tabacum* sperm cells. *Plant Cell* 6:1477-1484.
76. Russell, S. D. 1994. Fine structure of megagametophyte development. In: *Embryology of Flowering Plants: Terminology and Concepts. Volume I. Generative Organs of Flowers*, Professor Tatyana B. Batygina, Editor, pp. 202-206. World and Family Publishers, St. Petersburg, Russia. 1994. (Received in October 1995)

77. Russell, S. D., G. W. Strout, A. K. Stramski, T. W. Mislan, R. A. Thompson and L. M. Schoemann. 1996. Development polarization and morphogenesis of the generative and sperm cells of *Plumbago zeylanica*. 1. Descriptive cytology and three-dimensional organization. *American Journal of Botany* 83: 1435-1453.
78. Cao, Y., A. Reece and S.D. Russell. 1996. Isolation of sperm cells of *Nicotiana tabacum*. *Zygote* 4: 81-84.
79. Russell, S.D. 1996. Attraction and transport of male gametes for fertilization. *Sexual Plant Reproduction* 9: 337-342.
80. Cao, Y. and S. D. Russell. 1997. Mechanical isolation and ultrastructural characterization of viable egg cells in *Plumbago zeylanica*. *Sexual Plant Reproduction* 10: 368-373
81. Fields, S. D., G.W. Strout, and S. D. Russell. 1997. Spray-freezing freeze substitution (SFFS) of cell suspensions for improved preservation of ultrastructure. *Microscopy Research and Technique* 38: 315-328
82. Tian, H.Q. and S.D. Russell. 1997. Development changes in calcium distribution and accumulation in fertilized and unfertilized ovules and embryo sacs of *Nicotiana tabacum*. *Planta* 202: 93-105.
83. Tian, H.Q. and S.D. Russell. 1997. Micromanipulation of male and female gametes of *Nicotiana tabacum*. I. Isolation of gametes. *Plant Cell Reports* 16: 555-560.
84. Tian, H.Q. and S.D. Russell. 1997. Micromanipulation of male and female gametes of *Nicotiana tabacum*. II. Preliminary attempts for in vitro fertilization and egg cell culture. *Plant Cell Reports* 16: 657-661
85. Southworth, D., G. W. Strout and S. D. Russell. 1997. Freeze fracture of *Plumbago zeylanica* L. sperm in pollen and in vitro. *Sexual Plant Reproduction* 10: 217-226
86. Zhang, Z. and S. D. Russell. 1997. Immunofluorescent localization of myosin on the sperm cells of *Plumbago zeylanica*. *Proceedings of the Microscopy Society of America meetings*, pp. 183-184
87. Russell, S. D. 1998. Biology of the angiosperm male gamete and its role in fertilization. *Acta Agronomica Hungarica* 46: 409-413.
88. Russell, S.D. 1998. "Cytoplasmic transmission during fertilization" for the volume "Anther" in the book, *Modern Embryology. Terminology and Concepts*, Professor T. Batygina, editor. Komorov Botanical Institute, Leningrad, USSR, pp. 169-175.
89. Russell, S.D. 1998. "Fertilization mechanisms in flowering plants" for the volume "Anther" in the book, *Modern Embryology. Terminology and Concepts*, Professor T. Batygina, editor. Komorov Botanical Institute, Leningrad, USSR, pp. 186-192.
90. Russell, S.D. 1998. "In vitro fertilization in flowering plants" for the volume "Anther" in the book, *Modern Embryology. Terminology and Concepts*, Professor T. Batygina, editor. Komorov Botanical Institute, Leningrad, USSR, pp. 210-211.
91. Russell, S.D. 1998. "The male germ unit" for the volume "Anther" in the book, *Modern Embryology. Terminology and Concepts*, Professor T. Batygina, editor. Komorov Botanical Institute, Leningrad, USSR, pp. 127-135.
92. Tian, H. Q., A. Kuang, M. E. Musgrave, and S. D. Russell. 1998. Calcium distribution in fertile and sterile anthers of a photoperiod-sensitive genic male-sterile rice. *Planta* 205: 183-192.
93. Tian, H.Q., Z. Zhang, and S. D. Russell. 1998. Isolation of the male germ unit (MGU): organization and function in tobacco (*Nicotiana tabacum* L.) *Plant Cell Reports* 18: 143-147.
94. Tian, H.Q. and S. D. Russell. 1998. The fusion of sperm cells and the function of male germ unit (MGU) of tobacco (*Nicotiana tabacum* L.) *Sexual Plant Reproduction* 11: 171-176.
95. Zhang, Z. and S. D. Russell. 1998. Isolation and collection of two populations of viable sperm cells from the pollen of *Plumbago zeylanica* *Zygote* 6: 295-298.
96. Huang BQ, Sheridan WF, Russell SD. 1999. Cytoskeletal and nuclear behavior during female gametophyte development and fertilization in angiosperms. In: "Focus on Multidimensional Microscopy", Cheng PC, Hwang PP, Wu JL, Wang G (eds.). World Scientific Publ Co Pte Ltd., Singapore, pp. 89-97.
97. Okada T, Zhang Z, Russell SD, Toriyama K. 1999. Localization of the Ca<sup>2+</sup>-binding protein, Bra r 1, in anthers and pollen tubes. *Plant Cell Physiology* 40: 1243-1252.
98. Tian HQ, Russell SD. 1999. Culture-induced changes in osmolality of tobacco cell suspensions using four exogenous sugars. *Plant Cell, Tissue and Organ Culture* 55: 9-13.
99. Zhang Z, Russell SD. 1999. Sperm cell surface characteristics of *Plumbago zeylanica* in relation to transport in the embryo sac. *Planta* 208: 539-544.
100. Zhang Z, Tian HQ, Russell SD. 1999. Immunogold scanning electron microscopic localization of myosin on isolated sperm cells of tobacco (*Nicotiana tabacum* L.) *Protoplasma* 208: 123-128.
101. Tian HQ, Zhu H, Russell SD. 2000. Developmental changes in calcium distribution and accumulation in fertilized and unfertilized ovules and embryo sacs of *Plumbago zeylanica*. *Sexual Plant Reproduction* 13: 11-20.
102. Russell SD. 2001. Female gametogenesis: Ontogenesis of the embryo sac and female gametes. In: "Current Trends in the Embryology of Angiosperms," Bhojwani S, Soh WY (eds), Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 65-88.
103. Southworth D, Russell SD. 2001. Male gametogenesis: Development and structure of sperm. In: "Current Trends in the Embryology of Angiosperms," Bhojwani SS, Soh WY (eds), Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 1-16.
104. Tian HQ, Zhang Z, Russell SD. 2001. Sperm dimorphism in *Nicotiana tabacum* L. *Sexual Plant Reproduction* 14: 123-125.
105. Singh MB, Xu H, Bhalla P, Zhang Z, Swoboda I, Russell SD. 2002. Developmental expression of polyubiquitin genes and distribution of ubiquitinated proteins in generative and sperm cells. *Sexual Plant Reproduction* 14: 325-329.
106. Lord EM, Russell SD. 2002. Mechanisms of pollination and fertilization. *Annual Review of Cell and Developmental Biology* 18: (in press)

PAPERS PRESENTED AT PROFESSIONAL MEETINGS:

1978

With D. D. Cass. Post-fertilization development in *Plumbago zeylanica*. *Botanical Society of America Annual Meetings*, Blacksburg, Virginia.

1979

Developmental modifications of sperm structure during pollen tube growth in *Plumbago zeylanica*. *American Institute of Biological Sciences Annual Meetings*, Stillwater, Oklahoma.

1980 Gamete delivery and syngamy in Plumbago zeylanica. Botanical Society of America/Canadian Botanical Association Annual Meetings, Vancouver, British Columbia, Canada

1980 With D. D. Cass. "Ultrastructure of fertilization in Plumbago zeylanica". VI Symposium on Plant Cytoembryology, Lublin, Poland. (Presented by D. D. Cass.)

1981 Structure and quantitative cytology of male gametes in Plumbago zeylanica. XIII. International Botanical Congress, Sydney, Australia.

1981 Gamete delivery and gamete fusion in the flowering plant Plumbago zeylanica. Oklahoma Academy of Science/Oklahoma Society for Electron Microscopy Annual Meetings, Enid, Oklahoma.

1982 With D. D. Cass. "Ultrastructure of gamete fusion in Plumbago zeylanica" VII Symposium on Embryogenesis in Ovulated Plants. Bratislava, Czechoslovakia. (Presented by D. D. Cass.)

1982 With D. D. Cass. "Unequal distribution of plastids and mitochondria during sperm cell formation in Plumbago zeylanica." Symposium on Pollen Biology. Lake Garda, Italy. (Presented by D. D. Cass.)

1982 "Quantitative cytology and stereology of male gametes and transmitted male cytoplasmic organelles in Plumbago zeylanica." Botanical Society of America Annual Meetings. College Station, Pennsylvania.

1983 "Gametic fusion in Plumbago zeylanica: Ultrastructural evidence for gamete recognition and the preferential transmission of sperm plastids into the zygote." Botanical Society of America/Canadian Botanical Association Annual Meetings. Grand Forks, North Dakota.

1983 "Evidence for gametic recognition in the angiosperm Plumbago zeylanica." Oklahoma Academy of Science/Oklahoma Society for Electron Microscopy Annual Meetings, Tulsa, Oklahoma.

1984 "Timetable of Fertilization." Pollination '84, University of Melbourne, Melbourne, Australia.

1984 "Gametic recognition in Plumbago and its implications in angiosperm reproduction." VIII Symposium on the Embryogenesis of Ovulated Plants, Wageningen, The Netherlands.

1984 "Three-dimensional reconstruction in the study of the male gamete of a flowering plant." Oklahoma Academy of Science/Oklahoma Society for Electron Microscopy Annual Meetings, Ada, Oklahoma.

1984 "Megagametophyte development in Nandina domestica Thunb. and its taxonomic implications." With M. Ehdaie. Oklahoma Academy of Science, Ada, Oklahoma.

1985 "Microgametogenesis in Plumbago zeylanica." Botanical Society of America annual meetings. Gainesville, Florida.

1985 "Biphasic pollen tube growth in Plumbago zeylanica." Biotechnology and Ecology of Pollen Symposium. Amherst, Massachusetts.

1985 "Development, polarization, and morphogenesis of the generative cell, and studies on sperm specificity in Plumbago zeylanica." International Conference on Angiosperm Male Gamete Structure. Flagstaff, Arizona.

1985 "Dimorphic sperm cells, cytoplasmic transmission and preferential fertilization in the synergid-less angiosperm, Plumbago zeylanica." The Chondriome. Second Wye International Symposium. Wye, Ashford, Kent, United Kingdom.

1985 "Isolation of sperm cells of Plumbago zeylanica." The Chondriome. Second Wye International Symposium. Wye, Ashford, Kent, United Kingdom.

1985 "Isolation of sperm cells of Plumbago zeylanica." Oklahoma Academy of Science/Oklahoma Society for Electron Microscopy Annual Meeting, Shawnee, Oklahoma.

1985 "Compositional analysis of tooth amalgam". With W. F. Chissoe. Oklahoma Academy of Science/Oklahoma Society for Electron Microscopy Annual meeting. Shawnee, Oklahoma.

1986 "Microtubule-organelle associations during generative cell polarization in Plumbago zeylanica." With T. W. Mislan. Electron Microscopy Society of America Annual Meeting. Albuquerque, New Mexico.

1987 "Ultrastructure of fertilization." XIV International Botanical Congress. West Berlin, Federal Republic of Germany.

1987 "Polarization in the generative cell of Plumbago zeylanica." Second International Conference on Flowering Plant Sperm Cells. Wageningen, Netherlands.

1987 "Two-dimensional electrophoretic studies of protein and polypeptides in mature pollen grains of Plumbago zeylanica." With N. R. Geltz. Oklahoma Academy of Sciences Annual Meeting. Alva, Oklahoma.

1987 "Isolation of embryo sacs and eggs of Plumbago zeylanica." With B. Q. Huang. Oklahoma Academy of Sciences Annual Meeting. Alva, Oklahoma.

1987

1992 "Synergid degeneration in Nicotiana: a light, transmission and scanning electron microscopic study." With B.-Q. Huang. XII International Congress on Sexual Plant Reproduction, Columbus, Ohio.

1992 "The ultrastructural organization of freeze-substituted ovules of Nicotiana tabacum before and after fertilization." With B.-Q. Huang and G. W. Strout. XII International Congress on Sexual Reproduction, Columbus, Ohio.

1992 "Cytoskeletal organization within the embryo sac before and after fertilization in Nicotiana and Plumbago." With B.-Q. Huang. XII International Congress on Sexual Plant Reproduction, Columbus, Ohio.

1992 "Computer-assisted three-dimensional reconstruction of generative cell mitosis in pollen tubes of Nicotiana." With H.-S. Yu. XII International Congress on Sexual Plant Reproduction, Columbus, Ohio.

1992 "Three-dimensional reconstruction and quantitative cytology in pollen of Cymbidium goeringii." With H.-S. Yu. XII International Congress on Sexual Plant Reproduction, Columbus, Ohio.

1992 "Male cytoplasmic transmission during fertilization in Nicotiana." With B.-Q. Huang and H.-S. Yu. XII International Congress on Sexual Plant Reproduction, Columbus, Ohio.

1992 "Development of a spray freezing apparatus for the rapid cryofixation of a fragile, unicellular alga." With Fields, S. D. and G. W. Strout. Annual Meeting of Oklahoma Academy of Science/Oklahoma Society for Electron Microscopy, Lawton, Oklahoma.

1992 "Cytoskeletal organization within the embryo sac before and after fertilization in Nicotiana." With B.-Q. Huang. Annual Meeting of Oklahoma Academy of Science/Oklahoma Society for electron Microscopy, Lawton, Oklahoma.

1992 "Fertilization in flowering plants." Annual Meetings of Crop Sciences Society of America, Minneapolis, Minnesota.

1992 "Mitochondria entrapped within the sperm nucleus of Nicotiana tabacum." With H.-S. Yu. Annual meeting of Oklahoma Academy of Science/Oklahoma Society for Electron Microscopy, Lawton, Oklahoma.

1992 "Occurrence of mitochondria inside the sperm nucleus of tobacco." With H.-S. Yu. Annual Meeting of American Society of Cell Biology, Denver, Colorado.

1993 "Gametes, cytoskeleton and fertilization in angiosperms." Congress on Cell and Tissue Culture, San Diego, California.

1993 "Ultrastructure and three-dimensional organization of mitosis in generative cells of Nicotiana tabacum." With H.-S. Yu. Annual Meeting of Botanical Society of America/Canadian Botanical Association, Iowa State University, Ames, Iowa.

1993 "Spray-freezing apparatus for cryofixation of unicellular algae." With S. D. Fields and G. W. Strout. 51st Annual Meeting of the Microscopy Society of America, Cincinnati, Ohio.

1993 "Fertilization in flowering plants." Gordon Research Conference, Plymouth, New Hampshire.

1993 "Cytoskeletal organization within the embryo sac before and after fertilization in Plumbago and Nicotiana." XV International Botanical Congress, Yokohama, Japan.

1993 "Mitosis in the generative cell of tobacco (Nicotiana tabacum): Ultrastructural and three-dimensional organization." Oklahoma Microscopy Society/Oklahoma Academy of Science Annual Meeting, Ada, Oklahoma.

1994 "Endosymbiosis of the free-living alga *Chroomonas* in *Gymnodinium acidotum*: Quantification of endophyte modifications revealed by serial reconstruction." With S. D. Fields. Oklahoma Microscopy Society/Oklahoma Academy of Science Annual Meeting, Ada, Oklahoma.

1994 "Fertilization in higher plants." Ninth Annual Symposium on Plant Physiology. Pennsylvania State University, State College, Pennsylvania.

1994 "Gametes, cytoskeleton and fertilization in two flowering plant model systems." With B.-Q. Huang. XIII International Congress on Sexual Plant Reproduction, University of Vienna, Vienna, Austria.

1994 "Acquisition of chloroplasts through phagotrophy in the freshwater dinoflagellate *Gymnodinium acidotum*." With S. D. Fields. Oklahoma Microscopy Society/Oklahoma Academy of Science, Norman, Oklahoma.

1995 "Ultrastructural characterization of isolated sperm cells of the genus *Plumbago*." With G. W. Strout, D. Southworth, A. Reece and S. D. Fields. Oklahoma Microscopy Society/Oklahoma Academy of Science, Norman, Oklahoma.

1995 "Calcium distribution and accumulation in ovules and embryo sacs of Nicotiana tabacum." With H. G. Rian. Harnessing Apomixis: A New Frontier in Plant Science, Texas A & M University, College Station, TX, September 25-27, 1995.

1995 "Calcium distribution and accumulation in ovules and embryo sacs of the synergid-lacking angiosperm *Plumbago zeylanica*." With H. Zhu. Harnessing Apomixis: A New Frontier in Plant Science, Texas A & M University, College Station, TX, September 25-27, 1995.

1995 "Microscopy of the Internet: a tool for communication, education and research." Oklahoma Microscopy Society/Oklahoma Academy of Science Annual Meeting, Alva, Oklahoma, November 3, 1995.

"Computer assisted three-dimensional portrayal of plant reproductive cell development." With A. K. Stramski. Oklahoma Academy of Sciences Annual Meeting. Alva, Oklahoma.

1987 "Generative cell polarization in Plumbago zeylanica: development and morphogenesis". With G. W. Strout. Oklahoma Academy of Sciences/Oklahoma Society for Electron Microscopy. Alva, Oklahoma.

1988 "Analysis and characterization of mature pollen protein and polypeptides of Plumbago." With N. R. Geltz. Botanical Society of America Annual Meetings. University of California, Davis, California.

1988 "Isolation and characterization of isolated embryo sac and eggs of Plumbago." With B-Q. Huang and G. W. Strout. Botanical Society of America Annual Meetings. University of California, Davis, California.

1988 "Three-dimensional organization of generative cells during polarization and morphogenesis of Plumbago zeylanica." With A. K. Stramski and G. W. Strout. Botanical Society of America Annual Meetings, University of California, Davis, California.

1989 "Generative cell polarization and formation of the male germ unit in Plumbago zeylanica". Laboratoire Reconnaissance Cellulaire et Amelioration des Plants. Universite Claude Bernard-Lyon 1, Villeurbanne Cedex, France.

1989 "Characterization of the male gamete of the angiosperm Plumbago zeylanica". BAP meeting of European Economic Community, Universite Claude Bernard-Lyon 1, Villeurbanne Cedex, France.

1989 "Three-dimensional reconstruction in generative cell development and sperm organization: importance, methodology and results". Third meeting of the plant sperm cell club, Agricultural Research Institute, Hungarian Academy of Sciences, Martonvasar, Hungary.

1989 "Gamete isolation in angiosperms." NATO Advances in Science Workshop; "Mechanism of Fertilization: Plants to Man." Hotel Tramontano, Sorrento, Italy.

1990 "Isolation and characterization of gametes of Plumbago." With B-Q. Huang. AIBS/BSA Annual Meetings. Richmond Center. Richmond, Virginia.

1990 "Energy-dispersive x-ray microanalysis of cellular components in the pollen of an angiosperm, Plumbago zeylanica." XII International Congress for Electron Microscopy. Seattle, Washington.

1990 "Cytoskeletal organization and modification in the process of fertilization of Plumbago zeylanica." With B.Q. Huang. Oklahoma Academy of Science, Section K, Electron Microscopy, Tulsa.

1990 "Sperm cells in the pollen tube of Nicotiana." With H.S. Yu. Oklahoma Academy of Science, Section K, Electron Microscopy, Tulsa.

1991 "Cytoskeleton organization and modification during fertilization in Plumbago zeylanica." With B.-Q. Huang. TSEM/Ok-SEM Joint Spring Workshop on 3-D imaging, Arlington, Texas.

1991 "Origin of dimorphic sperm cells in the angiosperm Plumbago zeylanica." With G. W. Strout. TSEM/Ok-SEM Joint Spring Workshop on 3-D imaging, Arlington, Texas.

1991 "Three dimensional reconstruction and quantitative cytology of the pollen of an orchid, Cymbidium goeringii." With H.-S. Yu. TSEM/Ok-SEM Joint Spring Workshop on 3-D Imaging, Arlington, Texas.

1991 "Double fertilization in flowering plants." Developmental Biology Society of America, mini-symposium on "Sexual Reproduction in Plants," Marquette University, Milwaukee, Wisconsin.

1991 "Video microscopy of organelle movement in growing pollen tubes and isolated embryo sacs." With E. S. Pierson, B.-Q. Huang, I. K. Lichtscheidt and M. Cresti. International Symposium on Angiosperm Pollen and Ovules. Basic and Applied Aspects. Villa Olmo, Como, Italy.

1991 "Male cytoplasmic diminution in generative and sperm cells of flowering plants." With H.-S. Yu. American Institute of Biological Sciences/Botanical Society of American Annual Meetings, San Antonio, Texas.

1991 "Fertilization in Nicotiana: synergid degeneration and cytoskeleton modification." With B.-Q. Huang. American Institute of Biological Sciences/Botanical Society of American Annual Meetings, San Antonio, Texas.

1991 "Cytoskeleton organization and modification during fertilization in Nicotiana and Plumbago." with B.-Q. Huang. Oklahoma Academy of Science/Ok-SEM Fall Meeting, Durant, Oklahoma.

1991 "Three-dimensional ultrastructure of generative cell mitosis in the pollen tubes of Nicotiana tabacum." with H.-S. Yu. Oklahoma Academy of Science/Ok-SEM Fall Meeting, Durant, Oklahoma.

1992 "Generative cell mitosis in pollen tubes of Nicotiana tabacum: ultrastructure and three-dimensional reconstruction." With H.-S. Yu. 50th Annual Meeting of the Electron Microscopy Society of America, Boston, Massachusetts.

1992 "Freeze-fracture observations of the sperm cells of Plumbago zeylanica in the pollen grain and after isolation." With G. W. Strout. American Institute of Biological Sciences/Botanical Society of America, Honolulu, Hawaii.

1992

1995 "Surface charge of *Plumbago* sperm cells estimated from microelectrophoretic mobility." With Z. Zhang. Oklahoma Microscopy Society/Oklahoma Academy of Science Annual Meeting, Alva, Oklahoma, November 3, 1995.

1995 "The observation of calcium-induced precipitations in *Plumbago zeylanica* ovule." With H. Zhu. Oklahoma Microscopy Society/Oklahoma Academy of Science Annual Meeting, Alva, Oklahoma, November 3, 1995.

1995 "Toward *in vitro* fertilization in *Plumbago zeylanica*." With Y. Cao. Oklahoma Microscopy Society/Oklahoma Academy of Science Annual Meeting, Alva, Oklahoma, November 3, 1995.

1995 "Sperm cell surface characteristics of flowering plants in relation to transport in the embryo sac." With Z. Zhang. American Society for Cell Biology, Annual Meetings, December 8-13, 1995, Washington, D. C.

1996 "Cell surface biology of male gametes of *Plumbago zeylanica*." 14th International Congress of Sexual Plant Reproduction, Lorne, Australia, February 18-23, 1996.

1996 "Structural considerations in angiosperm fertilization." Banbury Center Conference, Cold Spring Harbor Laboratory, NY, April 21-24, 1996.

1996 "Attraction and transport of male gametes for fertilization." 75th Birthday Symposium on Sexual Reproduction in Angiosperms for Professor Hans F. Linskens, Nijmegen, Netherlands, April 26-27, 1996.

1996 "Fertilization in flowering plants." Plant Developmental Genetics symposium, Federation of American Societies for Experimental Biology (FASEB), Summer Research Conference, August 10-15, 1996, Saxtons River, VT.

1997 "Sexual reproduction and fertilization in flowering plants." School of Botany, University of Porto, Porto, Portugal, May 20, 1997.

1997 "Attraction and transport of male gametes for fertilization." Botanical Society of America/Canadian Botanical Association Annual Meetings, Montreal, Quebec, Canada, August 3-7, 1997.

1997 "Construction and maintenance of Internet sites: rewards and drawbacks." Botanical Society of America/Canadian Botanical Association Annual Meetings, Montreal, Quebec, Canada, August 3-7, 1997.

1997 "Plant gametes and fertilization." With D. Southworth. Botanical Society of America/Canadian Botanical Association Annual Meetings, Montreal, Quebec, Canada, August 3-7, 1997.

1997 "Scanning electron microscopy study of isolated sperm cells of tobacco (*Nicotiana tabacum*). " With Z. Zhang. Oklahoma Microscopy Society/Oklahoma Academy of Science Annual Meeting, Chickasha, November 7, 1997.

1998 "Collection and characterization of male gametes of *Plumbago* and *Nicotiana*." With Z. Zhang and H-Q. Tian. Botanical Society of America Annual Meetings, Baltimore, Maryland, August 2-6, 1998.

1998 "Flowering plant sperm cell collection, fusion and transport." With Z. Zhang and H-Q. Tian. 15th International Congress on Sexual Plant Reproduction, Wageningen, Netherlands, August 16-21, 1998

1998 "Immunolocalization of myosin on the surface of isolated sperm cells of tobacco (*Nicotiana tabacum*) and its relation to sperm cell transport." With Z. Zhang and H-Q. Tian. 15th International Congress on Sexual Plant Reproduction, Wageningen, Netherlands, August 16-21, 1998

1998 "Biology of the angiosperm male gamete and its role in fertilization." International Symposium on Molecular and Biotechnical Aspects of Sexual Reproduction in Higher Plants (ICRO-UNESCO and FAO Symposium), Martonvasar, Hungary, August 23-25, 1998.

1998 "Comparison of hexamethyldisilazane and critical point drying on the surface structure of *Nicotiana tabacum* pollen tubes." With Z. Zhang. Oklahoma Microscopy Society/Oklahoma Academy of Science Annual Meeting, Tahlequah, November 14, 1998.

1998 "Freeze-substitution of *Brassica* anthers for preserving *Bra r I*, a pollen allergenic protein." With Z. Zhang, T. Okada and K. Toriyama. Oklahoma Microscopy Society/Oklahoma Academy of Science Annual Meeting, Tahlequah, November 14, 1998.

1999 "Short-distance transport of sperm cells during fertilization in angiosperms." XVI International Botanical Congress, St. Louis, Missouri, USA, August 1-7, 1999.

1999 "Heterospermy during male germ unit maturation in *Nicotiana tabacum*." Development of gametes in flowering plants, D. Southworth and M.B. Singh, organizers. XVI International Botanical Congress, St. Louis, Missouri, USA, August 1-7, 1999, with Zhang, Z., and H.Q. Tian.

1999 "Heterospermy and preferential fertilization in tobacco." XVI International Botanical Congress, St. Louis, Missouri, USA, August 1-7, 1999, with Zhang, Z., and H.Q. Tian.

1999 "Ovule development." 3rd International EPS Conference. Catholic University, Nijmegen, The Netherlands, November 1-4, 1999.

1999

"Sperm-egg interactions." 3rd International EPS Conference. Catholic University, Nijmegen, The Netherlands, November 1-4, 1999.

2000 "Sperm collection and isolation for cDNA libraries." With Z. Zhang, H. Xu, I. Swoboda, P. Bhalla, M. B. Singh. XVI International Congress on Sexual Plant Reproduction, Banff Centre, Canada, April 1-5, 2000.

2000 "Interactivity on the Internet and interactive learning environments." Botanical Society of America Annual Meetings, Portland, Oregon, August 6-10, 2000.

2000 "Plumbago zeylanica sperm isolation, collection and cDNA library characterization." With Z. Zhang, H. Xu, I. Swoboda, P. Bhalla, M. B. Singh. Botanical Society of America Annual Meetings, Portland, Oregon, August 6-10, 2000.

2000 "Biology of angiosperm sperm cells." Frontiers in Sexual Plant Reproduction, Department of Biological Sciences, SUNY, Albany, New York, October 28-29, 2000.

2001 "Cell cycle, sperm dimorphism and sperm cell biology in flowering plants / Internet resources for botany". Texas Microscopy Society annual workshop, keynote speaker, Houston, TX, April 5, 2001.

2001 "Relationship between double fertilization and the cell cycle in male and female gametes of tobacco." With HQ Tian and T Yuan. Botany 2001 meeting of the Botanical Society of America, Albuquerque, NM, August 12-16, 2001.

INVITED PRESENTATIONS:

1980 "Male gametes and fertilization in angiosperms." With D. D. Cass. Botanical Society of America/Canadian Botanical Association Symposium: "Gametogenesis, Fertilization, and Embryo Development in Angiosperms." (Presented by D. D. Cass.)

1982 "Fertilization in Plumbago zeylanica: The structural basis of male cytoplasmic inheritance." Oklahoma State University, Stillwater, Oklahoma.

1983 "Fertilization in Plumbago zeylanica." University of Texas, Austin, Texas.

1984 "Timetable of fertilization in angiosperms." Pollination '84, International Symposium. University of Melbourne, Melbourne, Australia.

1984 "Gametic recognition in Plumbago and its implications in angiosperm reproduction. "VIII Symposium on the Embryogenesis of Ovulated Plants, Wageningen, The Netherlands.

1985 "Fertilization in Plumbago zeylanica and the concept of dimorphic sperm cells." University of California, Riverside, California.

1985 "Fertilization in angiosperms." University of California, Berkeley, California.

1985 "Dimorphic sperm cells, cytoplasmic transmission, and preferential fertilization in the synergid-less angiosperm, Plumbago zeylanica." The Chondriome, International Symposium, Wye College, University of London, Wye, Ashford, Kent, U.K.

1985 "Dimorphic sperm cells and preferential fertilization in Plumbago zeylanica." Agricultural University, Wageningen, Netherlands.

1987 "Fertilization in angiosperms and the concept of preferential fertilization." Auburn University, Auburn, Alabama.

1987 "Ultrastructure of fertilization". XIV International Botanical Congress, West Berlin, Federal Republic of Germany.

1987 "Polarization in the generative cell of Plumbago zeylanica". Second Conference on Flowering Plant Sperm Cells. Wageningen, Netherlands.

1988 "Dimorphic sperm cells and preferential fertilization in Plumbago." University of Georgia, Athens, Georgia.

1988 "Sperm cell isolation, characterization and dimorphism". Modern Advances in Flowering Plant Embryogenesis, Peking University, Beijing, P.R. China.

1988 "Development, polarization and morphogenesis of the generative cell of Plumbago zeylanica". Modern Advances in Flowering Plant Embryogenesis. Peking University, Beijing, P.R. China.

1988 "Techniques, rationales and procedures for conducting quantitative cytology and three-dimensional reconstruction". Modern Advances in Flowering Plant Embryogenesis, Peking University, Beijing, P.R. China.

1988 "Fertilization in angiosperms. Conceptual framework and evolutionary speculation". Modern Advances in Flowering Plant Embryogenesis, Peking University, Beijing, P. R. China.

1988

"Generative cell morphogenesis and sperm formation in Plumbago zeylanica". Beijing Forestry University, Beijing, P.R. China.

1989 "Generative cell development and fertilization in Plumbago zeylanica". Universite Claude Bernard-Lyon 1, Villeurbanne Cedex, France.

1989 "Characterization of the male and female gametes of Plumbago zeylanica". Dipartimento di Biologie Ambientale, Universita di Siena, Siena, Italy.

1989 "Characterization of the male gamete of the angiosperm Plumbago zeylanica". BAP meeting of European Economic Community, Universite Claude Bernard-Lyon 1, Villeurbanne Cedex, France.

1989 "Biochemical and hybridoma antibody characterization of the male germ unit of Plumbago zeylanica". Université Claude Bernard-Lyon 1, Villeurbanne Cedex, France.

1989 "Fertilization in Populus deltoides: Implications for male cytoplasmic inheritance." Oklahoma Academy of Science, Keynote address, Section K, Electron Microscopy.

1989 "Gamete isolation in angiosperms." NATO Advances in Science Workshop; "Mechanisms of Fertilization Plants to Man." Hotel Tramontano, Sorrento, Italy.

1989 "New concepts in fertilization in flowering plants." Oklahoma State University, Stillwater, Oklahoma.

1990 "Fertilization in angiosperms." Department of Anatomical Sciences, OU Health Sciences Center, Oklahoma City, Oklahoma

1990 "Isolation and characterization of gametes of Plumbago." AIBS/BSA meeting, symposium "Plant Gametes and Fertilization." Richmond Center, Richmond, Virginia.

1991 "Synergid handedness, male cytoplasmic reduction and related topics." Oklahoma State University, Stillwater, Oklahoma.

1991 "Gamete isolation, characterization and fertilization in flowering plants." Division of Plant Biology, Samuel Roberts Noble Foundation, Ardmore, Oklahoma.

1991 "Female gamete and gametophyte organization and function in flowering plants." Plant Development minisymposium on "Plant Sexual Reproduction," Society for Developmental Biology, Marquette University, Milwaukee, Wisconsin.

1992 "Fertilization in flowering plants." Crop Sciences Society of America Meetings, Minneapolis, Minnesota.

1992 "Cytoskeletal organization within the embryo sac before and after fertilization in Nicotiana and Plumbago." With B.-Q. Huang. XII International Congress on Sexual Plant Reproduction, Columbus, Ohio.

1993 "Fertilization in angiosperms." IRBV & Department of Biology, University of Montreal, Quebec, Canada.

1993 "Fertilization in flowering plants." Department of Botany, University of Toronto, Toronto, Ontario, Canada.

1993 "Gametes, cytoskeleton and fertilization in angiosperms." Congress on Cell and Tissue Culture, San Diego, California.

1993 "Fertilization in flowering plants." Gordon Research Conference on "Fertilization." Plymouth, New Hampshire.

1993 "Cytoskeletal organization within the embryo sac before and after fertilization in Plumbago and Nicotiana." XV International Botanical Congress, Yokohama, Japan.

1994 "Fertilization in higher plants" Ninth Annual Symposium on Plant Physiology. Pennsylvania State University, State College, Pennsylvania.

1995 "Fertilization in flowering plants: New techniques and insights." Department of Botany, Oklahoma State University, Stillwater, Oklahoma.

1996 "Cell surface biology of male gametes of Plumbago zeylanica." 14th International Congress of Sexual Plant Reproduction, Lorne, Australia, February 18-23, 1996.

1996 "Emerging concepts in the study of sexual reproduction in angiosperms." Distinguished Visiting Lecturer series, University of Adelaide, Adelaide, Australia, February 27, 1996.

1996 "Structural considerations in angiosperm fertilization." Banbury Center Conference, Cold Spring Harbor Laboratory, NY, April 21-24, 1996.

1996 "Attraction and transport of male gametes for fertilization." 75th Birthday Symposium on Sexual Reproduction in Angiosperms for Professor Hans F. Linskens, Nijmegen, Netherlands, April 26-27, 1996.

1996 "Fertilization in flowering plants." Plant Developmental Genetics symposium, Federation of American Societies for Experimental Biology (FASEB), Summer Research Conference, August 10-15, 1996, Saxtons River, VT.

1997

"Sexual reproduction and fertilization in flowering plants." School of Botany, University of Porto, Porto, Portugal, May 20, 1997.

1997 "Attraction and transport of male gametes for fertilization." Botanical Society of America/Canadian Botanical Association Annual Meetings, Montreal, Quebec, Canada, August 3-7, 1997.

1997 "Construction and maintenance of Internet sites: rewards and drawbacks." Botanical Society of America/Canadian Botanical Association Annual Meetings, Montreal, Quebec, Canada, August 3-7, 1997.

1997 "Calcium in pollen tube attraction, ovule fertility and synergid receptivity." Plant Molecular Biology and Biotechnology Group, Institute of Land and Food Resources, University of Melbourne, Parkville, Australia, October 15, 1997.

1997 "Generative cell formation, development and morphogenesis" Department of Agriculture and Resource Management, University of Melbourne, Parkville, Australia, November 12, 1997.

1997 "Fertilization in angiosperms." Department of Botany, Latrobe University, Bundoora, Melbourne, Australia, December 3, 1997.

1998 "Flowering plant sperm cell collection, fusion and transport." With Z. Zhang and H-Q. Tian. 15th International Congress on Sexual Plant Reproduction, Wageningen, Netherlands, August 16-21, 1998

1998 "Biology of the angiosperm male gamete and its role in fertilization." International Symposium on Molecular and Biotechnical Aspects of Sexual Reproduction in Higher Plants (ICRO-UNESCO and FAO Symposium), Martonvasar, Hungary, August 23-25, 1998.

1999 "Short-distance transport of sperm cells during fertilization in angiosperms." XVI International Botanical Congress, St. Louis, Missouri, USA, August 1-7, 1999.

1999 "Heterospermy and preferential fertilization in tobacco." Development of gametes in flowering plants, D. Southworth and M.B. Singh, organizers. XVI International Botanical Congress, St. Louis, Missouri, USA, August 1-7, 1999, with Zhang, Z., and H.Q. Tian.

1999 "Fertilization in flowering plants." Department of Botany, Miami University, Oxford, Ohio, October 22, 1999.

1999 "Ovule development." 3rd International EPS Conference. Catholic University, Nijmegen, The Netherlands, November 1-4, 1999.

1999 "Sperm-egg interactions." 3rd International EPS Conference. Catholic University, Nijmegen, The Netherlands, November 1-4, 1999.

2000 "Interactivity on the Internet and interactive learning environments." Botanical Society of America Annual Meetings, Portland, Oregon, August 6-10, 2000.

2000 "Biology of angiosperm sperm cells." Frontiers in Sexual Plant Reproduction, Department of Biological Sciences, SUNY, Albany, New York, October 28-29, 2000.

2000 "Two topics: Sperm cell biology and Accessing Internet Resources in Biology". Department of Resource Management and Horticulture, University of Melbourne, Parkville, Victoria, Australia, November 29, 2000.

2000 "Cell cycle, sperm dimorphism and preferentiality in flowering plant fertilization." CSIRO Plant Industry Division, Canberra, Australia, December 1, 2000.

2001 "Cell cycle, sperm dimorphism and sperm cell biology in flowering plants / Internet resources for botany". Texas Microscopy Society annual workshop, keynote speaker, Houston, TX, April 5, 2001.

2001 "Relationship between double fertilization and the cell cycle in male and female gametes of tobacco" Department of Biological Sciences, University of Auckland, Auckland, New Zealand, December 5, 2001.

**ABSTRACTS PUBLISHED:**

1. Russell, S. D. and D. D. Cass. 1978. Post-fertilization development in *Plumbago zeylanica*. Botanical Society of America Abstracts. Allen Press, Lawrence, Kansas. Miscellaneous Series Publications 156:41.
2. Russell, S. D. 1979. Developmental modifications of sperm structure during pollen tube growth in *Plumbago zeylanica*. Botanical Society of America Abstracts. Allen Press, Lawrence, Kansas. Miscellaneous Publication Series 157:18.
3. Russell, S. D. 1980. Gamete delivery and syngamy in *Plumbago zeylanica*. Botanical Society of America/Canadian Botanical Association Abstracts. Allen Press, Lawrence, Kansas. Miscellaneous Series Publication 158:98-99.
4. Russell, S. D. 1981. Structure and quantitative cytology of male gametes of *Plumbago zeylanica*. XIII International Botanical Congress, Sydney, Australia, August 17-29. XIII International Botanical Congress Abstracts, pg. 61.
5. Russell, S. D. 1981. Gamete delivery and gamete fusion in the flowering plant *Plumbago zeylanica*. OK SEM Newsletter 5(1):10.
6. Russell, S. D. 1982. Quantitative cytology and stereology of male gametes and transmitted male cytoplasmic organelles in *Plumbago zeylanica*. Botanical Society of America Abstracts. Miscellaneous Series Publication 162:23.

77. Zhang, Z., Tian, H. Q and S. D. Russell. Heterospermy during male germ unit maturation in *Nicotiana tabacum*. Late Abstracts of the XVI International Botanical Congress, August 1-7, 1999, St. Louis, Missouri, USA, pg. 26
78. Russell, S.D., Z. Zhang, H. Xu, I. Swoboda, P. Bhalla and M. B. Singh 1999. Discrimination of flowering plant sperm cells using structural and molecular probes. OMS Bulletin 21(2): 19.
79. Russell, S.D., Z. Zhang, H. Xu, I. Swoboda, P. Bhalla and M. B. Singh. 2000. Sperm collection and isolation for cDNA libraries. Proceedings of the XVI International Congress on Sexual Plant Reproduction, Banff Centre, Canada, pg. 35
80. Russell, S.D. 2000. Interactivity on the Internet and interactive learning environments. Am. J. Bot. 87(6, suppl. 2): 186.
81. Russell, S.D., Z. Zhang, H. Xu, I. Swoboda, P. Bhalla and M. B. Singh. 2000. *Plumbago zeylanica* sperm isolation, collection and cDNA library characterization. Am. J. Bot. 87(6, suppl. 2): 31.
82. Russell, S.D. 2000. Biology of angiosperm sperm cells. Abstracts of Frontiers in Sexual Plant Reproduction, Department of Biological Sciences, SUNY, Albany, New York, October 29, 2000, pg. 30.
83. Russell, S.D., H.Q. Tian, T. Yuan and Z. Zhang. 2000. Coordinated cell cycle in male and female gametes of tobacco during double fertilization Oklahoma Microscopy Society Bulletin 22(2): 10.
84. Russell, S.D. 2001. Two Topics: Cell cycle, sperm dimorphism and sperm cell biology in flowering plants / Internet resources for botany. Proceedings of TSM Spring Meeting, Houston Marriott, Medical Center, Houston, TX, April 5-7, 2001
85. Tian, H.Q., T. Yuan and S.D. Russell. 2001. Relationship between double fertilization and the cell cycle in male and female gametes of tobacco. Proceedings of Botany 2001, Annual Meeting of the Botanical Society of America, Albuquerque, NM, August 12-16, 2001, pg 26.

**RESEARCH FUNDING:**

**External:**

1982-85 National Science Foundation. Division of Physiology, Cellular and Molecular Biology-Developmental Biology Program. "Investigations into sperm-specificity and transmission of male cytoplasmic organelles during early embryogenesis in the angiosperm *Plumbago zeylanica*". \$70,000.

1984-88 National Science Foundation. Division of Physiology, Cellular and Molecular Biology -Developmental Biology Program. "Generative cell formation, polarization and morphogenesis in *Plumbago zeylanica* as the developmental basis for sperm specificity." \$102,378.

1984 National Science Foundation. Biological Instrumentation Program. "Acquisition of a new scanning electron microscope." \$129,740. (not funded)

1985 National Science Foundation. Division of Physiology, Cellular and Molecular Biology-Developmental Biology Program. "Acquisition of eucentric gonimeter for use with a Zeiss 10a transmission electron microscope." \$3,500 (supplemental grant)

1985 National Science Foundation. Division of Physiology, Cellular and Molecular Biology-Developmental Biology Program. "Gametogenesis, fertilization and early embryogenesis in *Drimys*: reproduction in a putatively primitive angiosperm." \$72,000 (supplemental grant).

1985 United States Department of Agriculture. Competitive Grants Program -Genetic Mechanisms. "Sexual reproduction in *Pisum* and *Phaseolus*: a comparison of gametic fusion mechanisms in flowering plants with differing patterns of male cytoplasmic inheritance." \$174,095. (not funded)

1986-88 United States Department of Agriculture. Competitive Grants Program Biotechnology/Plant Growth and Development Program. "Isolation and characterization of male and female gametes of the angiosperm *Plumbago zeylanica*." \$91,000

1986 State of Oklahoma - MOST Program. "Acquisition of Analytical Electron Microscopy Equipment." \$150,000.

1986 State of Oklahoma - MOST Program. "Acquisition of a Quantitative Electron Microprobe." \$250,000. Funding redirected to purchase analytical electron microscopy equipment.

1986 Department of Energy-Coal Research Program. "Acquisition of a Quantitative Electron Microprobe." (with D. London) \$620,000.

1986 Department of Education. "Acquisition of Analytical Electron Microscopy Equipment and Creation of an Electron Microprobe Facility." \$500,000.

1987 State of Oklahoma - MOST Program, "Matching Funds for Energy-Dispersive X-Ray Analysis System." \$100,000.

1987-88 University of Pennsylvania. "Ultrastructural Effects of Acid Rain on the Needles of Red Spruce, *Picea rubens*". (billable contract)

1987 National Science Foundation. Developmental Biology Program. "Supplemental Award to Involve Undergraduates in Studies of Sperm Organization in *Plumbago zeylanica*". \$4,000 (supplemental grant).

1988-91 United States Department of Agriculture. Competitive Grants Program. Molecular and Cellular Mechanisms of Plant Growth and Development. "Isolation and characterization of male and female gametes of the angiosperm *Plumbago zeylanica*." \$150,000.

43. Huang, B.-Q. and S. D. Russell. 1992. Cytoskeletal organization within the embryo sac before and after fertilization in *Nicotiana*. Annual Meeting of Oklahoma Academy of Science/Oklahoma Society for Electron Microscopy, Lawton, Oklahoma. OkSEM Newsletter 14(2):14.

44. Yu, H.-S. and S. D. Russell. 1992. Mitochondria entrapped within the sperm nucleus of *Nicotiana tabacum*. Annual meeting of Oklahoma Academy of Science/Oklahoma Society for Electron Microscopy, Lawton, Oklahoma. OkSEM Newsletter 14(2):13.

45. Yu, H.-S. and S. D. Russell. 1992. Occurrence of mitochondria inside the sperm nucleus of tobacco. Annual Meeting of American Society of Cell Biology, Denver, Colorado. Molecular Biology of the Cell 3 (Suppl.): 1066.

46. Russell, S. D. 1993. Gametes, cytoskeleton and fertilization in angiosperms. Congress on Cell and Tissue Culture, San Diego, California, In Vitro Cellular and Developmental Biology, pg. 17.

47. Russell, S. D. 1993. Cytoskeletal organization within the embryo sac before and after fertilization in *Plumbago* and *Nicotiana*. XV International Botanical Congress, Yokohama, Japan, pg. 97.

48. Yu, H.-S. and S. D. Russell. 1993. Ultrastructure and three-dimensional organization of mitosis in generative cells of *Nicotiana tabacum*. Annual meeting of Botanical Society of America/Canadian Botanical Association, Ames, Iowa. American Journal of Botany 80 (6, supplement): 39-40.

49. Fields, S. D. and S. D. Russell. 1993. Endosymbiosis of the free-living alga *Chroomonas* in *Gymnodinium aciculatum*: Quantification of endophyte modifications revealed by serial reconstruction. Oklahoma Microscopy Society/Oklahoma Academy of Science Annual Meeting, Ada, Oklahoma. OMS Newsletter 15 (2): 12.

50. Russell, S. D. and H.-S. Yu. 1993. Mitosis in the generative cell of tobacco (*Nicotiana tabacum*): ultrastructural and three-dimensional organization. Oklahoma Microscopy Society/Oklahoma Academy of Science Annual Meeting, Ada, Oklahoma. OMS Newsletter 15 (2): 14.

51. Russell, S. D. and B.-Q. Huang. 1994. Gametes, cytoskeleton and fertilization in two flowering plant model systems. Abstracts of the XIII International Congress on Sexual Plant Reproduction, University of Vienna, Vienna, Austria, p. 22.

52. Fields, S. D. and S. D. Russell. 1994. Acquisition of chloroplasts through phagotrophy in the freshwater dinoflagellate *Gymnodinium aciculatum*. OMS Bulletin 16 (2):11.

53. Strout, G. W., D. Southworth, A. Reece, S. D. Fields and S. D. Russell. 1994. Ultrastructural characterization of isolated sperm cells of the genus *Plumbago*. OMS Bulletin 16 (2):14.

54. Cao, Y. and S. D. Russell. 1995. Toward *in vitro* fertilization in *Plumbago zeylanica*. OMS Bulletin 17 (2):13.

55. Russell, S. D. 1995. Microscopy on the Internet: a tool for communication, education and research. OMS Bulletin 17(2):17.

56. Tian, H. Q. and S. D. Russell. 1995. Calcium distribution and accumulation in ovules and embryo sacs of *Nicotiana tabacum*. Harnessing Apomixis: A New Frontier in Plant Science, Texas A & M University, College Station, TX, September 25-27, pg. 77.

57. Zhang, Z. and S. D. Russell. 1995. Sperm cell surface characteristics of flowering plants in relation to transport in the embryo sac. American Society for Cell Biology, Annual Meetings, December 8-13, 1995, Washington, D. C., pg.

58. Zhang, Z. and S. D. Russell. 1995. Surface charge of *Plumbago* sperm cells estimated from microelectrophoretic mobility. OMS Bulletin 17 (2):14.

59. Zhu, H. and S. D. Russell. 1995. The observation of calcium-induced precipitation in *Plumbago zeylanica* ovule. OMS Bulletin 17 (2):14.

60. Zhu, H. and S. D. Russell. 1995. Calcium distribution and accumulation in ovules and embryo sacs of the synergid-lacking angiosperm *Plumbago zeylanica*. Harnessing Apomixis: A New Frontier in Plant Science, Texas A & M University, College Station, TX, September 25-27, pg. 38.

61. Cao, Y. and S. D. Russell. 1996. PEG-induced fusion between isolated eggs in *Plumbago zeylanica*. OMS Bulletin 18 (2): 14.

62. Russell, S. D., and H. Q. Tian. 1996. Basis of antimonate precipitation to detect loosely-bound calcium and its relationship to sexual reproduction in tobacco, *Nicotiana tabacum*. OMS Bulletin 18 (2): 14.

63. Southworth, D., G. W. Strout, and S. D. Russell. 1996. Freeze fracture of *Plumbago* sperm. Proceedings of the XIV International Congress of Sexual Plant Reproduction, University of Melbourne, Melbourne, Australia, pg. 49.

64. Zhang, Z., G. W. Strout, H. Zhu, and S. D. Russell. 1996. Cell surface biology of male gametes of *Plumbago zeylanica*. Proceedings of the XIV International Congress of Sexual Plant Reproduction, University of Melbourne, Melbourne, Australia, pg. 42.

65. Russell, S. D. 1997. Attraction and transport of male gametes for fertilization. American Journal of Botany 84 (6, suppl.): 33.

66. Russell, S. D. 1997. Construction and maintenance of Internet sites: rewards and drawbacks. American Journal of Botany 84 (6, suppl.): 256.

67. Southworth, D. and S. D. Russell. 1997. Plant gametes and fertilization. American Journal of Botany 84 (6, suppl.): 33.

68. Zhang, Z. and S. D. Russell. 1997. Scanning electron microscopy study of isolated sperm cells of tobacco (*Nicotiana tabacum*). OMS Newsletter 19(2): 18.

69. Mattison, S. and S. D. Russell. 1998. Comparison of hexamethyldisilazane and critical point drying on the surface structure of *Nicotiana tabacum* pollen tubes. OMS Newsletter 20(2): 22.

70. Russell, S. D., Z. Zhang and H-Q. Tian. 1998. Collection and characterization of male gametes of *Plumbago* and *Nicotiana*. American Journal of Botany 85(6, suppl.): 18.

71. Russell, S. D., Z. Zhang, M.B. Singh, H. Xu, I. Swoboda, and P. Bhalla. 1998. Relearning how to do microscopy in a molecular lab in Australia. OMS Newsletter 20(2): 23.

72. Zhang, Z, T. Okada, K. Toriyama and S. D. Russell. 1998. Freeze-substitution of *Brassica* anthers for preserving *Brassica* I, a pollen allergenic protein. OMS Newsletter 20(2): 20.

73. Zhang, Z, H-Q. Tian, and S. D. Russell. 1998. Immunolocalization of myosin on the surface of isolated sperm cells of tobacco (*Nicotiana tabacum*) and its relation to sperm cell transport. Proceedings of the 15th International Congress on Sexual Plant Reproduction, Wageningen, Netherlands, pg. 118.

74. Zhang, Z, H-Q. Tian and S. D. Russell. 1998. Flowering plant sperm cell collection, fusion and transport. Proceedings of the 15th International Congress on Sexual Plant Reproduction, Wageningen, Netherlands, pg. 46.

75. Russell, S. D. 1999. Short-distance transport of sperm cells during fertilization in angiosperms. Abstracts of the XVI International Botanical Congress, August 1-7, 1999, St. Louis, Missouri, USA, pg. 103

76. Zhang, Z, Tian, H. Q and S. D. Russell. Heterosperry and preferential fertilization in tobacco. Abstracts of the XVI International Botanical Congress, August 1-7, 1999, St. Louis, Missouri, USA, pg. 566

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8. Russell, S. D. 1984. Evidence for gametic recognition in the angiosperm Plumbago zeylanica. Ok-SEM Newsletter 6(1):12.
9. Russell, S. D. 1984. Gametic recognition and its implications in angiosperm reproduction. VIII Symposium on the Embryogenesis of Ovulated Plants, Wageningen, The Netherlands, pg. 46.
10. Russell, S. D. 1984. Three-dimensional reconstruction in the study of the male gamete of flowering plant. Ok-SEM Newsletter 6(2):7.
11. Russell, S. D. 1985. Microgametogenesis in Plumbago zeylanica. Amer. J. Bot. 72 (6): 830-831.
12. Russell, S.D. 1985. Biphasic pollen tube growth in Plumbago zeylanica. In: Biotechnology and Ecology of Pollen Symposium, Amherst, Massachusetts.
13. Russell, S. D. 1985. Dimorphic sperm cells, cytoplasmic transmission, and preferential in the synergid-less angiosperm, Plumbago zeylanica. In: The Chondriome Second International Symposium, Wye College, University of London, Wye, U.K.
14. Russell, S. D. 1985. Isolation of sperm cells in Plumbago zeylanica. In: The Chondriome Second International Symposium, Wye College, University of London, Wye, U.K.
15. Russell, S. D. 1987. Sperm dimorphism and preferential gametic fusion in Plumbago zeylanica. In: Proceedings of the XIV International Botanical Congress.
16. Stramski, A. K., and S. D. Russell. 1987. Computer-assisted three-dimensional portrayal of plant reproductive cell development. Ok-SEM Newsletter 9(2):9.
17. Strout, G. W., and S. D. Russell. 1987. Generative cell polarization in Plumbago zeylanica: development and morphogenesis. Ok-SEM Newsletter 9(2):9.
18. Geltz, N. R. and S. D. Russell. 1988. Analysis and characterization of mature pollen protein and polypeptides of Plumbago. Amer. J. Bot. 75(6):28.
19. Huang, B-Q., G. W. Strout, and S. D. Russell. 1988. Isolation and characterization of isolated embryo sacs and eggs of Plumbago. Amer. J. Bot. 75(6):33-34.
20. Russell, S. D., A. K. Stramski, and G. W. Strout. 1988. Three-dimensional organization of generative cells during polarization and morphogenesis of Plumbago zeylanica. Amer. J. Bot. 75(6):44.
21. Russell, S. D., and L. J. Mao. 1989. Relationships in sporophytic-gametophytic symmetry in Linum usitatissimum. Amer. J. Bot. 76(6):55.
22. Russell, S.D., M. Rougier, and C. Dumas. 1989. Fertilization in Populus deltoides: Implications for male cytoplasmic inheritance. Ok-SEM Newsletter 11: 20.
23. Russell, S. D. and B. Q. Huang. 1990. Isolation and characterization of gametes of Plumbago. Amer. J. Bot. 77(6):7.
24. Huang, B-Q. and S. D. Russell. 1990. Cytoskeletal organization and modification in the process of fertilization of Plumbago zeylanica. Ok-SEM Newsletter 12(2):17.
25. Yu, H-S. and S.D. Russell. 1990. Sperm cells in the pollen tube of Nicotiana. Ok-SEM Newsletter 12(2):17.
26. Russell, S. D. and H.-S. Yu. 1991. Male cytoplasmic diminution in generative & sperm cells of flowering plants. American Journal of Botany 78 (6, suppl.): 26.
27. Huang, B.-Q., and S. D. Russell. 1991. Fertilization in Nicotiana: synergid degeneration and cytoskeleton modification. American Journal of Botany 78 (6, suppl.): 34.
28. Huang, B.-Q., and S. D. Russell. 1991. Cytoskeletal organization and modification during fertilization in Plumbago zeylanica. TSEM Bulletin, Ok-SEM Bulletin 13(1) 31.
29. Yu, H.-S. and S. D. Russell. 1991. Three-dimensional reconstruction and quantitative cytology of the pollen of an orchid, Cymbidium goeringii. TSEM Bulletin, Ok-SEM Bulletin 13(1): 28.
30. Russell, S. D. and G. W. Strout. 1991. Origin of dimorphic sperm cells in the antiosperm Plumbago zeylanica. TSEM Bulletin, Ok-SEM Bulletin 13(1):29.
31. Pierson, E. S., B.-Q. Huang, I. K. Lichtscheidl, S. D. Russell and M. Cresti. 1991. Video microscopy of organelle movement in growing pollen tubes and isolated embryo sacs. International symposium on angiosperm pollen and ovules. Basic and applied aspects, Villa Olmo, Como, Italy, pg. 50.
32. Huang, B.-Q. and S. D. Russell. 1991. Cytoskeletal organization and modification during fertilization in Nicotiana and Plumbago. Ok-SEM Bulletin 13(2):39.
33. Yu, H.-S. and S. D. Russell. 1991. Three-dimensional ultrastructure of generative cell mitosis in the pollen tubes of Nicotiana tabacum. Ok-SEM Bulletin 13(2):36.
34. Russell, S. D. and G. W. Strout. 1992. Freeze-fracture observations of the sperm cells of Plumbago zeylanica in the pollen grain and after isolation. American Journal of Botany (6, supplement): 116.
35. Huang, B.-Q. and S. D. Russell. 1992. Synergid degeneration in Nicotiana: a light, transmission and scanning electron microscope study. Abstracts of XII International Congress on Sexual Plant Reproduction, pg. 29.
36. Huang, B.-Q., G. W. Strout and S. D. Russell. 1992. The ultrastructural organization of freeze-substituted ovules of Nicotiana tabacum before and after fertilization. Abstracts of XII International Congress on Sexual Plant Reproduction, pp. 29-30.
37. Russell, S. D. and B.-Q. Huang. 1992. Cytoskeletal organization within the embryo sac before and after fertilization in Nicotiana and Plumbago. Abstracts of XII International Congress on Sexual Plant Reproduction, pg. 58.
38. Yu, H.-S. and S. D. Russell. 1992. Computer-assisted three dimensional reconstruction of generative cell mitosis in pollen tubes of Nicotiana. Abstracts of XII International Congress on Sexual Plant Reproduction, pg. 80.
39. Yu, H.-S. and S. D. Russell. 1992. Three-dimensional reconstruction and quantitative cytology in pollen of Cymbidium goeringii. Abstracts of XII International Congress on Sexual Plant Reproduction, pg. 79.
40. Yu, H.-S., B.-Q. Huang and S. D. Russell. 1992. Male cytoplasmic transmission during fertilization in Nicotiana. Abstracts of XII International Congress on Sexual Plant Reproduction, pg. 79.
41. Russell, S. D. 1992. Fertilization in flowering plants. Abstracts of Crop Sciences Society of America Meetings, Minneapolis, Minnesota, pg. 309.
42. Fields, S. D., G. W. Strout and S. D. Russell. 1992. Development of a spray freezing apparatus for the rapid cryofixation of a fragile, unicellular alga. Annual Meeting of Oklahoma Academy of Science/Oklahoma Society for Electron Microscopy, Lawton, Oklahoma. OkSEM Newsletter 14(2):12.

National Science Foundation. Directorate for Biological Instrumentation and Resources, Multi-User Biological Equipment and Instrument Resources Program. "Acquisition of a confocal laser scanning microscope" \$106,281 proposed (total cost of proposal: \$212,562) (Denied)

1995-98 National Aeronautics and Space Administration. "Sexual reproduction of flowering plants in microgravity" \$239,593 (not funded)

1995-98 United States Department of Agriculture. National Research Initiative Competitive Grants Program - Plant Growth and Development. "Gamete interactions during fertilization in angiosperms." \$95,888 (NRICRP grant #95-37304-2361)

1997-98 University of Melbourne, Senior Researcher Travel Grants Scheme (with Prof. M. Singh). "Characterization of genes of the generative cell of *Lilium*". A\$6,000

1998-99 University of Melbourne, Senior Researcher Collaborative Research Grants Scheme (with Prof. M. Singh). "Characterization of gene expression of sperm cells of *Plumbago zeylanica*". A\$10,000

1997-99 Praxis XXI, JNICT, Lisboa, Portugal. "Biologia da reprodução em Amaranthus de grão (Amaranthus hypochondriacus L.) cecamismos de atracção e diccionamento do tubo polínico." 6,750,000 Escudos (submitted by Prof. Roberto Salema, Universidad da Porto) as proposed funded collaborator (denied funding)

1997-99 United States Department of Agriculture. National Research Initiative Competitive Grants Program - Plant Growth and Development. "Gamete interactions during fertilization in angiosperms." \$100,000 (NRICRP grant #95-37304-2361)

1999-2002 United States Department of Agriculture. National Research Initiative Competitive Grants Program - Plant Growth and Development. "Flowering plant fertilization: attraction, interaction & transport of gametes" \$150,000 (NRICRP grant #99-35304-8097).

2000-2003 National Science Foundation. Directorate for Integrative and Neurobiology. Plant and Microbial Developmental Mechanisms Program. "Sperm-expressed genes in the flowering plant *Plumbago zeylanica*" \$834,807 (denied).

2000-2003 United States Department of Agriculture. National Research Initiative Competitive Grants Program - Plant Growth and Development. "Flowering plant fertilization: Interaction and biology of gametes" \$335,888 (denied).

2000-2003 National Science Foundation. Major Instrumentation Program. "Acquisition of multiuser confocal fluorescence microscope" \$217,000 (denied) total project \$308,000.

Internal Funding:

1981 Arts and Sciences Summer Fellowship. "Relationship of Sperm Cytoplasmic Organelles and Destiny of Male Gametes During Gamete Fusion in *Plumbago zeylanica*." \$3500.

1982 Research Council. "Purchase of a diamond knife to support studies into sperm-specificity in the angiosperm *Plumbago zeylanica*." \$2260.

1983 Research Council. Purchase of fluorescence microscope attachments for investigating the cell surface of flowering plant gametes." \$4830.

1984 Research Council "Examination of the developmental basis of sperm-specificity in the male gamete of a flowering plant." \$4100.

1985 Research Council "Acquisition of micromanipulator to isolate the egg of a flowering plant for *in vitro* fertilization." \$1150.

1985 OU Associates Research/Creative Activity Fund "Equipment for quantitative fluorescence microscopy." \$30,000 (with P.B. Bell, J. N. Farmer, H. Haines, J. Murphy and T. Yoshino).

1986 Research Council "Protein characterization equipment for studies on fertilization in flowering plants". \$5,000.

1987 OU Associates Research/Creative Activity Fund "An ultrarapid propane jet freezing device". \$9,800 (with L. A. Pfeister, J. S. Fletcher, B. M. Fung and W. Ortiz-Leduc).

1987 OU Interdisciplinary Research Support Fund "Technical and operations support for interdisciplinary electron microscopic research". \$51,000. (not funded)

1988 Career Development Grant "Training for new electron microscopy equipment". \$5,000.

1988 Biomedical Research Support Grant "Research support for electron microscopy work". \$16,055

1989 Biomedical Research Support Grant "Acquisition of cryo-pumped freeze-fracture device". \$12,500

1990 Personal Computer Proposal, Merrick Computer Center "Three-dimensional reconstruction facility for electron microscopy." \$6,502

1991

1988-90 University of Pennsylvania. "Ultrastructural effects of acid rain on the needles of red spruce, *Picea rubens*." \$10,000

1990-92 National Science Foundation. Cell Biology Program. "Biochemical and physiological characterization of the male gamete of a cytoplasmically heterospermic angiosperm". \$278,976 (denied).

1990-92 Department of Energy. Biological Energy Program. "Biochemical and physiological characterization of the male gamete of a cytoplasmically heterospermic angiosperm." \$278,976 (denied).

1990-91 North Atlantic Treaty Organization. Grants for International Collaboration in Research. "Characterization of cytoskeleton of flowering plant gametes during development and fertilization. " BF 200,000 (approx. \$5,150).

1990-91 Italian Ministry of Research, Rome, Italy. Support for visiting post doctoral research associate for six months. 15,800,000 lire (approx. \$13,000).

1990 National Science Foundation. Division of Cellular Biosciences. Development Biology Program. "Symposium: 'Plant gametes and fertilization' at the American Institute of Biological Sciences meeting in Richmond, VA, August, 1990." \$5,000 (Co-PI, Darlene Southworth).

1990 Pioneer HiBreds International. "Symposium: 'Plant gametes and fertilization' at the American Institute of Biological Sciences meeting in Richmond, VA, August, 1990." \$1,500.

1990 Botanical Society of America. "Symposium: 'Plant gametes and fertilization' at the American Institute of Biological Sciences meeting in Richmond, VA, August, 1990." \$1,000.

1990-92 National Science Foundation. Division of Cellular Biosciences. Instrumentation and Instrument Development Program. "Acquisition of a Confocal Scanning Laser Microscope for Biological Research." \$150,926 (total, denied) (co-PIs Paul B. Bell, Jr., Joseph A. Bastian, Ming-Chen Liu, Lois Pfeister and Brian R. Waldrop).

1990-91 Kerr-McGee. "Materials research using electron microscopic methods." (billable contract) (co-PI Bill Chissoe).

1990-91 Support Services Engineering Corporation. "Materials fracture and corrosion deposit research." (billable contract)

1990-93 Oklahoma Center for the Advancement of Science and Technology. Applied Research Program, "Development of *in vitro* fertilization in an angiosperm." \$135,984 (denied funding).

1990-92 Samuel Roberts Noble Foundation, Ardmore. "Research on elemental distribution in plant tissues using electron microscopy." (cooperative agreement)

1991-92 North Atlantic Treaty Organization. Grants for International Collaboration in Research. "Characterization of cytoskeleton of flowering plant gametes during development and fertilization. " BF 200,000 (. approx. \$7,000). (denied funding)

1991-92 Hitachi Computer Corporation, Norman. "Analysis of magnetic heads of hard disks using electron microscopy." (cooperative agreement)

1991-92 National Science Foundation. Division of Cellular Biosciences. Instrumentation and Instrument Development Program. Acquisition of a confocal scanning microscope for multi-disciplinary studies. (With P. B. Bell, Jr., Joseph A. Bastian, Paul S. Begovac, Ming-Cheh Liu, Lois Pfeister and John Waldrop) \$113,540 ([matching funds] total project \$222,910, denied)

1991-96 United States Department of Agriculture. National Research Initiative Competitive Grants Program—Plant Growth and Development Program. "Cytoskeleton during fertilization in flowering plants." #91-37304-6471

1992-95 United States Department of Education. Graduate Assistance in Areas of National Need (GAANN) Program. Approx. \$400,000 (on writing committee, not a direct participant). (denied)

1992-93 CONOCO Inc., Ponca City. "Electron microscopic analysis of physical sciences specimens." (cooperative agreement)

1992-94 National Science Foundation, Developmental Biology Program. "Ultrastructural organization of the mitotic apparatus in the bicellular pollen of *Nicotiana tabacum*." \$173,374 (denied)

1993-94 Samuel Roberts Noble Foundation, Ardmore. "Research on elemental distribution in plant tissues using electron microscopy." (cooperative agreement)

1993-94 Look Incorporated, Ada. "Evaluation of surgical needles and improvements in preparation of surfaces." (cooperative agreement)

1993-95 National Science Foundation. Systematic Biology Program. "Molecular and ultrastructural adaptations characterizing the transient symbiosis between *Glenodiniopsis acidotum* and *Chroomonas* sp." \$5,300 (With S. Fields) NSF grant #DEB-9311481

1994-97 National Science Foundation. Directorate for Integrative and Neurobiology. Developmental Mechanisms Program. "Gamete interactions in flowering plants" \$285,548 proposed. (Denied)

1994-96

Research Council. "Acquisition of preparation equipment for physical sciences transmission electron microscopy". (co-  
PIs: G. Atkinson, T. Batchman, R. Daniels and D. London) \$7,500 (matching funds: \$5,760; total project: \$13,260).

1991      OU Research Council. "Acquisition of metal mirror contact-freezing device" (with L. Beevers, M-C. Liu) \$6,700.

1995      OU Research Council. "Purchase of osmometer to support studies into in vitro fertilization in flowering plants" \$4,341.

1996      Vice President for Research. "Upgrade existing energy-dispersive x-ray analysis system for scanning electron  
microscopy" \$18,000 (Total project cost: \$22,500)

1996      Research Council. "Laser Tweezers to support research on in vitro fertilization in angiosperms." \$10,000 (Total project  
cost: \$11,500) (denied)

1998      Travel support for airfare to Australia sought and received from Vice President for Research, Dean of College of Arts  
and Sciences and Department. (Total: \$1,650)

1999      Vice President for Research. "Upgrade existing energy-dispersive x-ray analysis system for transmission electron  
microscopy" \$22,000 (Total project cost: \$29,500)

Instructional Funding - Internal:

1993      Instructional Resources Program. "Acquisition of Video Microscopy Equipment for Botany Courses." \$8,500 (with G. E.  
Uno)

1994      Instructional Resources Program. "Facilities enhancements for General Botany laboratories" \$13,000 (with G.E. Uno)